

Glan Llyn, Newport
Phase 5E1
Chemical Validation Report

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Chemical Validation Report

for

St. Modwen Developments Ltd

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1.0 Introduction

1.1 Terms of Reference

Rodgers Leask Ltd (RLL) has been commissioned by St. Modwen Developments Ltd to prepare a Chemical Validation Report following the remediation of Phase 5E1 of the Glan Llyn development in Newport (hereafter referred to as the 'Site').

NRW provided comments on other phases (Phase 4D & Phase 4H) of the development, therefore version P02 of this report has been prepared to address applicable comments for this Phase (5E1).

The Site is situated within the Glan Llyn development on the site of the former Llanwern Steelworks. The Site location is shown on RLL drawing 18669-RLE-21-XX-DR-O-0137 (**Appendix A**).

This report should be read in conjunction with the Glan Llyn Remediation Strategy (Ref. 18669-RLL-21-XX-RP-O-0157) and Phase 5E1 & 5E2 Earthworks Specification (Ref. 18669-RLL-22-XX-RP-O-0214). The relevant earthworks performance criteria have been included in this validation report for ease of reference.

1.2 Objectives

In accordance with the requirements of Planning Condition 28 of Outline Planning Permission Reference 06/0471, this report has been prepared to verify that the remediation works, undertaken by McCarthy Contractors (Bridgend) Ltd with Phase 5E1 between May and September 2022, were completed in general accordance with the RLL Earthworks Specification (**Ref. 1**) and the RLL Phase 5E1 Remediation Strategy (**Ref. 4**).

1.3 Proposed Development

The Site is proposed to be redeveloped for a residential end use. An illustrative masterplan (ref. 8111-08-A011, dated April 2019) is available in **Appendix A**. Phase 5E1 will form part of the wider Glan Llyn development.

1.4 Purpose

This report has been prepared pursuant to the partial discharge (P1 - pre-construction stage) of Planning Condition 28 of the Outline Planning Permission Reference 06/0471 for the proposed development of residential development Phase 5E1 as part of a wider mixed use development at Llanwern, Newport.

Planning Condition 28 states the following:

Prior to the commencement of each phase of development as defined by Condition 03 (that is any development excluding that required as part of the remediation strategy), unless an alternative timescale for the component parts of that phase and/or for specific remediation works has firstly been agreed in writing by the Local

Planning Authority, a verification report demonstrating completion of the works set out in the approved remediation strategy for that phase (or each part of the phase if an alternative timescale has been agreed by the Local Planning Authority for the component parts) and the effectiveness of the remediation shall be submitted and approved, in writing, by the Local Planning Authority. The report shall include results of sampling and monitoring carried out in accordance with the approved verification plan for that phase to demonstrate that the site remediation criteria has been met. It shall also include any plan for longer-term monitoring of pollutant linkages, maintenance and arrangements for contingency action, as identified in the verification plan, and for the reporting of this to the Local Planning Authority.

Reason: To demonstrate that the remediation criteria relating to controlled waters have been met and (if necessary) to secure longer-term monitoring of groundwater quality. This will ensure that there are no longer remaining unacceptable risks to controlled waters following remediation of the site and in the interests of residential amenities and human health.

As discussed with NRW, a phased approach to the discharge of Condition 28 is considered prudent, with (P1) relating to pre-construction stage validation, and (P2) relating to the construction stage validation.

It was therefore proposed that, in accordance with previously approved phases of the development, pursuant to the partial discharge of PC28 relating to the interim state of remediation following pre-construction stage (P1), a validation report for pre-construction remedial works demonstrating that these works be undertaken in accordance with the approved Remediation Strategy.

In order to discharge PC 28 in full for each phase, the future housebuilder undertaking the construction stage will be required to provide suitable documentation to demonstrate that the construction phase remedial works (P2) have been completed to a satisfactory condition.

1.5 References

The following documents have been referred to in the preparation of this report:

- Glan Llyn Phase 5E1 and 5E2 Earthworks Specification, RLL, ref. 18669-RLL-22-XX-RP-O-0214, dated February 2021 (**Ref. 1**).
- Glan Llyn Phase 5E1 Desk Study and Phase 2 Geo-Environmental Report, RLL, ref. 18669-RLE-21-XX-RP-O-0183_P04, August 2023 (**Ref. 2**)
- Former Llanwern Steelworks Site Assessment of Asbestos Contamination, The Institute of Occupational Medicine (IOM), 610-34464, March 2014 (**Ref. 3**)
- Phase 5E1 Remediation Strategy, RLL, ref. 18669-RLL-23-XX-RP-O-0474, August 2023 (**Ref. 4**)
- Glan Llyn CWDQRA, RLL ref. 18669-RLL-19-XX-RP-O-0006_Rev A, dated June 2022 (**Ref. 5**)
- Phase 5E1 CWDQRA, RLL ref. 18669-RLL-23-XX-RP-O-0477, dated August 2023 (**Ref. 6**)

- Glan Llyn CWDQRA Validation Plan, RLL, ref. 18669-RLL-22-XX-RP-O-0260, dated June 2022 (**Ref. 6**)
- Glan Llyn Remediation Strategy Addendum Information, RLL, ref. 18669-RLL-22-XX-RP-O-0192, dated January 2022 (**Ref. 7**)
- Barnes, G.E. 2010. Soil Mechanics Principles and Practise. 3rd Edition. Palgrave Macmillan, Hampshire (**Ref. 8**)

1.6 Limitations and Confidentiality

All conclusions and recommendations made within this report are based upon and limited to the factual information obtained as part of these works. No responsibility can be taken by RLL for information obtained by third parties and it has been assumed that all third party information provided is true and correct.

RLL has undertaken the work in accordance with our understanding of current best practice at the time of undertaking the work. Further assessment and revision of this report may be required should new information come to light or legislation/changes to best practice be introduced after the date of issue of the report.

RLL has prepared the report for the sole use and reliance of the Client. The report may not be used or relied upon by any unauthorised third party without the explicit written agreement of RLL.

The interpretive work undertaken within this report remains the intellectual property of RLL and must not be divulged to any commercial third party without prior written agreement of RLL.

2.0 Site Characteristics

2.1 Site Location and Description

The Phase 5E1 Site is located within the Glan Llyn development at the former Llanwern Steelworks, approximately 5.5km to the east of Newport City Centre centred at National Grid Reference 336462E, 186614N. The site location plan is shown on drawing 18669-RLE-21-XX-DR-O-0173, **Appendix A**.

The Site covers an area of approximately 7.03ha, comprises an area formerly used for the stockpiling of materials from the wider Llanwern Site, and is located near the south east boundary of the residential part of the wider Glan Llyn development.

Monk's Ditch is located approximately 100m east of the Site, it is separated from the former steelworks drainage bypassing site in a concrete channel; numerous other surface water features are recorded within 500m, mostly comprising reens and drains. The nearest proposed surface water feature is yet to be formed but shall be approximately 5m to the north of the Site.

The Site boundary is shown on drawing 02554-F-5e110-P0, **Appendix A**.

2.2 Site History Summary

Historically, the Site exclusively comprised agricultural land segregated into part of eight fields by hedgerows and drains, until 1967 where the Site was shown to form part of the Llanwern Steelworks, housing conveyors, hoppers, a stockhouse and several small associated structures, including a raised access ramp and various ore/coal stockyards. Railway sidings were present in the west, extending northwards offsite, also associated with the wider steelworks. The Site was demolished to slab level by 2004.

2.3 Ground Conditions and Contamination Summary

Historical and recent ground investigations undertaken prior to the remediation works, as summarised in the RLL Phase 2 Report (**Ref. 2**), generally identified the following conditions across the Site:

- Made Ground at thicknesses of 0.50m to 4.00m, comprising soft to firm gravelly clay with occasional to frequent cobbles; fused slag/gravel and cobbles of slag; or clayey gravelly sand. Cobbles and gravel consisted of concrete, clinker, limestone, brick, slate, slag, mudstone, quartzite and occasionally with fragments of metal or rebar.
- Tidal Flat Deposits from 1.10m to 11.30m, consisting of as very soft to firm bluish grey occasionally peaty clay. Rootlets, roots and gravel-sized peaty pockets were common throughout the strata horizons.
- Mercia Mudstone Group from 10.00m to 11.30m, described as extremely weak mudstone.

Oily sheens or hydrocarbon odours were encountered in five locations in the Made Ground at depths from 0.50m to 1.35m. Buried obstructions such as concrete,

asphalt and fused slag were encountered in fifteen locations between 0.12m to at least 2.00m.

As part of previous ground investigations undertaken by Atkins and RLL a total of 61 soil samples of Made Ground were collected and scheduled for analysis from across the Site. The results of the chemical analysis identified a relatively small number of exceedances of the LQM/CIEH S4ULs for residential end use with plant uptake (1% SOM). These exceedances related to arsenic, chromium, lead, mercury, nickel, vanadium, benzo(b)fluoranthene, benzo(a)pyrene, and dibenz(a,h)anthracene. Further details of this assessment are presented in RLL's Desk Study and Phase 2 Geo-Environmental Report (**Ref. 2**)

The 61 samples collected have also been assessed against the RLL Controlled Waters Detailed Quantitative Risk Assessment (CWDQRA) reuse criteria as discussed in the Phase 5E1 CWDQRA Addendum (**ref. 5**). Exceedances of this criteria were recorded for cyanide, iron, manganese, fluoranthene and benzo(b)fluoranthene, as shown in the following table.

Table 2.1: Summary of Exceedances of CWDQRA Residential Reuse Criteria				
Contaminant	No. of Exceedances	Location of Exceedances (Depth in m)	Concentration Range of Exceedances (mg/kg)	Reuse Criteria Value (mg/kg)
Cyanide (total)	7 of 61	AK21-2, AK22-1, AL21-1, , AP21-2, AQ21-1, AR21-2, AS20-1	3.4 - 9.2	2.3
Iron	2 of 52	AH30-2, AP21-2	374,000 - 397,000	349,148
Manganese	3 of 61	AH29-2, AL28-1, AL28-2, AL29-1	38,400 - 48,700	38,175
Fluoranthene	2 of 61	AK31-1, AK32-1	7.65 – 11.2	7.6
Benzo(b)fluoranthene	1 of 61	AK32-1	7.25	3.9

Asbestos was identified in two samples taken during the RLL investigation; quantification of two samples identified 0.007% and 0.020% asbestos. Made Ground will be screened and, if asbestos contamination is less than 0.02% (200PPM), then may be used in residential areas beneath the clean cover.

As part of the RLL 2021 ground investigation, perched water was encountered towards the base of the Made Ground in 24 locations at depths of 0.30m to 1.80m with an average depth of 1.20m. Due to the lack of sufficient volume of water, where encountered, no samples of perched groundwater were taken. According to the Phase 2 report (**Ref. 2**) regional groundwater was encountered within a gravelly fine to coarse sand at depths between 9.50mbgl and 11.00mbgl towards the base of the Tidal Flat Deposits. The groundwater is typically sub artesian, confined by the clay rich Tidal Flat Deposits at approximately 9.00mbgl, with a rest water level of approximately 3mbgl.

3.0 Enabling Works

3.1 Earthworks Summary

During previous intrusive ground investigations undertaken within the Site, the Made Ground was found to contain exceedances of relevant critical criteria for heavy metals, PAHs, cyanide and asbestos; as well as numerous buried obstructions. As such, remediation works were required.

Remedial earthworks were undertaken by McCarthy Contractors (Bridgend) Ltd between May and September 2022 in accordance with the RLL Earthworks Specification (**Ref. 1**) and the Remediation Strategy (**Ref. 4**). The earthworks generally comprised:

- Site clearance;
- Excavation of Made Ground to natural underlying Tidal Flat Deposits;
- Removal from site Made Ground with evidence of gross visual and olfactory contamination;
- Removal of below ground obstructions;
- Cropping of piles to the level of the underlying Tidal Flat Deposits;
- Re-engineering of Made Ground;
- In situ geotechnical testing;
- Soft spot excavation; and
- Monitoring for compliance with relevant specifications.

The purpose of the proposed works was to remove potentially unsuitable material following sitewide soil sampling and below ground obstructions during the turnover of the Made Ground.

The turnover of approximately 115,000m³ of Made Ground allowed for the surveying and chemical validation of the natural clay at the base of excavation, as shown on the McCarthy Contractors (Bridgend) Ltd 'Phase 5E1 Base of Excavation Clay Levels' drawing in **Appendix A**. Approximately 60,000m³ of stockpiled site won suitable material and pre-validated material from the adjacent Phase 5E2 was imported to achieve the formation levels. Chemical testing of the imported material is presented in Section 4. The reengineering of the material to create a low permeability Made Ground layer is in accordance with the Remediation Strategy (**Ref. 4**). The works also enabled existing obstructions to be uncovered and, where possible, removed.

In accordance with the RLL Earthworks Specification (**Ref. 1**) material excavated from Phase 5E1 and material located within stockpiles on the wider Glan Llyn development was to be used as fill within the Site to achieve the formation level of between 5.80mAOD and 7.30mAOD. The material was reengineered to achieve 95% compaction and <10% air voids. Formation levels are shown on PJA engineering constraints Drawing 02554-F-5e110-P0 (**Appendix A**). The Site is 750mm below the proposed final levels, to allow for placement clean cover.

Proposed extents of the Site are shown on PJA Drawing 2554-F-5e110-P0 taking into account tie in sections shown on PJA Drawing 2554-EE-0100-P0, presented in

Appendix A. The final earthworks levels are shown on the McCarthy Contractors (Bridgend) Ltd drawing 'Phase 5E1 Topo As Built Levels' in **Appendix A**.

3.2 Geotechnical Validation Testing

Geotechnical validation of the earthworks comprised laboratory geotechnical testing, California Bearing Ratio (CBR) testing, Electronic Soil Density Gauge (SDG) Non-Nuclear Test, and expansivity testing of the slag material. The appropriate compaction of the material is relevant in terms of limiting/ reducing the permeability to support the Remediation Strategy.

197 particle size distribution tests were undertaken on samples of the fill material used at the Site. The results indicated that the fill comprised clayey sandy gravel with occasional cobbles. 174 samples were classed as 2C – stony cohesive material (<15% fines) which is a General Cohesive Fill; and 23 samples were classed 1B – uniformly graded granular material (≥15% fines) which is a General Granular Fill.

Table 3.1 below shows the relevant performance criteria for material compaction set out in the earthworks specification and in situ test results recording compliance in accordance with the earthworks specification. A full summary of the geotechnical testing and in-situ compaction testing is presented in **Appendix C**.

Table 3.1 – Relevant Earthworks Performance Criteria & Validation Results					
Test	Required Limits		In-situ Results **		
	Min	Max	Min	Max	Average
Moisture Content (%)	6.6*	18*	4.5	26	12.4
Maximum Dry Density (Mg/m ³)	1.80*	3.08*	1.49	2.95	2.07
Degree of Compaction	Target 95% [minimum 90%] (Maximum Dry Density)		89	120	98.24
CBR Tests	Target 5%, Minimum 2.5%		3	44	12.28

* Taken from laboratory test results

** Soil Density Gauge (SDG)

831 of the 1070 SDG tests achieved 95% or greater relative compaction, and all tests achieved the minimum 89% or greater relative compaction. 35.5% (380 to 1070) of samples were found to be over 100% relative compaction and it is considered that this is resultant from the inherent variability of the Made Ground soils meaning an inappropriate Maximum Dry Density (MDD) may have been used by the geotechnical laboratory in calculating the percentage compaction for those results in excess of 100%.

180 in situ BS1377-2 moisture content tests were undertaken during the material placement, these were within the optimum value range with the exception of 5 tests. Two tests fell below the target range with a moisture content of 5%, and 3 moisture content tests resulted in higher than optimum moisture content to a maximum of 19%, slightly above the 18% higher threshold value.

15 of 113 equivalent California Bearing Ratio (CBR) values were below the target 5%, however all tests were in excess of the minimum 2.5% value.

3.3 Unsuitable Material

Drawing 18669-RLL-23-XX-DR-O-0443-P01 located in Appendix A shows the materials tracking. Material was verified in 25m² squares. No material was disposed off site. There were a number of locations where chemical unsuitable material was located within 30m of the watercourses, this material was subsequently relocated outside of the 30m zone. Additionally, there were a number of 25m² squares where material failed the site acceptance criteria for metals, however this material was retained on site.

3.4 Discussion

Some in situ density results are in excess of 100% which has been attributed to the range in MDD for the Made Ground soils. Additional lines of evidence comprising the consistency of the compaction methodology utilised throughout the works , subsequent compliant plate load testing undertaken across the finish formation and in situ permeability testing (Section 6), demonstrate that the material has been optimally compacted. The in situ density results together with the additional lines of evidence are therefore considered sufficient to demonstrate that the appropriate compaction has been achieved and that the earthworks have been undertaken in accordance with the earthworks specification.

4.0 Chemical Validation of Soils

4.1 General

The fill material used to achieve the proposed formation levels was predominantly granular, comprising sandy gravel with variable quantities of clay, silt and cobbles. The gravel was described as comprising slag, brick, quartzite and concrete.

As part of the RLL Phase 5E1 CWDQRA Addendum (**Ref. 6**) site specific data was used to confirm the suitability of the Site Acceptance Criteria based on 40% infiltration of rainwater in a residential area derived as part of RLL Site Wide CWDQRA (**Ref. 5**). The infiltration value used in the derivation of this criteria was based on the post remediation condition of the Site. The material was tested in accordance with the RLL Earthworks Specification (**Ref. 1**) and the RLL Remediation Strategy (**Ref. 4**).

Chemical testing was undertaken by Eurofins Chemtest Ltd; and gas monitoring was undertaken by RLL.

Fill material was sampled prior to placement by RLL between December 2020 and October 2022 during the various intrusive investigations undertaken across the Site.

Validation samples were taken from the natural deposits during the mass excavation operation to confirm that the Tidal Flat Deposits had not been impacted by contamination.

Validation sampling of the re-engineered formation surface was undertaken by RLL on a 50m grid at 100mm below the formation surface in September 2022. The formation surface validation sample locations are shown on RLL Drawing 18669-RLL-22-XX-DR-O-0326 (**Appendix A**).

Perched water sampling information is presented in Section 6.0.

4.2 Tidal Flat Deposits

Ten soil samples were collected from the Tidal Flat Deposits exposed during the earthworks and sent for contamination testing. Samples were tested for heavy metals, polycyclic aromatic hydrocarbons (PAH), total petroleum hydrocarbon (TPH), gasoline range organics (GROs), BTEX, pH, soil organic matter (SOM), ammoniacal nitrogen, cyanide, phenols and select samples were also tested for asbestos.

The samples were screened against the RLL Re-use Screening Criteria 40% Infiltration of Incident Rainfall for Residential Areas in accordance with the Remediation Strategy (**Ref. 4**). Two marginal exceedances of the criteria were recorded for ammoniacal nitrogen, although the average value was well below the critical value. The following Table 4.1 summarises the exceedances. A summary of the laboratory chemical results, screened against relevant assessment criteria, is presented in **Appendix C**. Laboratory certificates are presented in **Appendix D**.

Table 4.1 Summary of exceedances of 40% infiltration of Incident Rainfall for a residential end-use

Contaminant	No. of samples exceeding	Selected Screening Value (mg/kg)	Exceedances Concentration Range (mg/kg)	Upper 95 th Percentile of all samples (mg/kg)
Ammoniacal Nitrogen	2 of 10	176.983	180 - 190	185.5

Five samples submitted for laboratory analysis were screened for asbestos identification. No samples returned positive results.

4.3 Fill Material

A combined volume of approximately 175,000m³ of Made Ground makes up Phase 5E1. In accordance with the Remediation Strategy, prior to engineered placement, a total of 335 soil samples were collected between December 2020 and October 2022 for contamination testing, all of which were taken from stockpiled material allocated to be used in 5E1 as fill material. In-situ Made Ground or stockpiled Made Ground was sourced from Phase 5E1, the adjacent 5E2 and stockpiles on the wider Glan Llyn site.

Samples were tested for heavy metals, polycyclic aromatic hydrocarbons (PAH), total petroleum hydrocarbon (TPH), gasoline range organics (GROs), BTEX, pH, soil organic matter (SOM), ammoniacal nitrogen, cyanide, phenols, and half of samples were also tested for asbestos.

The samples were screened against the RLL Re-use Screening Criteria 40% Infiltration of Incident Rainfall for Residential Areas in accordance with the Remediation Strategy (**Ref. 5**). A summary of all laboratory chemical results is presented in **Appendix C**. Laboratory certificates are presented in **Appendix D**. The following table summarises the exceedances against screening criteria for 40% Infiltration of incident rainfall for residential areas in accordance with the Remediation Strategy.

Table 4.2a Summary of exceedances of RLL Re-use Screening Criteria 40% Infiltration of Incident Rainfall in Residential Areas for the Fill Material.

Contaminant	No. of samples exceeding (percentage of samples that exceeded)	Selected Screening Value (mg/kg)	Exceedances Concentration Range (mg/kg)	Upper 95 th Percentile of all samples (mg/kg)
Cyanide	52 of 335 (15.5%)	2.313	2.4 – 22.0	5.144
Ammoniacal Nitrogen	1 of 335 (0.29%)	15.2	180	16
Iron	3 of 328	349148.01	356000-430000	219550

Table 4.2a Summary of exceedances of RLL Re-use Screening Criteria 40% Infiltration of Incident Rainfall in Residential Areas for the Fill Material.				
Contaminant	No. of samples exceeding (percentage of samples that exceeded)	Selected Screening Value (mg/kg)	Exceedances Concentration Range (mg/kg)	Upper 95 th Percentile of all samples (mg/kg)
	(0.91%)			
Manganese	10 of 335 (2.99%)	38175.69	38,400-120,000	34,380
Vanadium	4 of 335 (1.19%)	1840.198	1960-2300	1260
Acenaphthylene	1 of 335 (0.29%)	19.168	32.3	1.79
Fluorene	1 of 335 (0.29%)	31.077	53	1.212
Phenanthrene	4 of 335 (1.19%)	31.077	36.4 - 226	10.24
Anthracene	2 of 335 (0.6%)	39.119	42.7 - 86	3.3
Fluoranthene	52 of 335 (15.5%)	7.614	7.65 - 331	19.6
Pyrene	1 of 335 (0.29%)	87.557	204	14.12
Benzo(b)fluoranthene	90 of 335 (26.87%)	3.914	3.95 - 121	12
Benzo(k)fluoranthene	8 of 335 (2.39%)	5.79	6.3 - 36.5	4.2
Benzo(a)pyrene	2 of 335 (0.6%)	39.489	55.0 - 71.9	9.7
Indeno(1,2,3-c,d)Pyrene	4 of 335 (1.19%)	29.018	30.0 - 56.7	7.18
Benzo[g,h,i]perylene	6 of 335 (1.79%)	15.229	18 - 49	5.92

Generally, less than 3% of samples exceed for individual contaminants and the 95th percentile concentrations. All contaminants are below the reuse criteria with the exception of cyanide, fluoranthene, and benzo(b)fluoranthene. The Three contaminants (cyanide, fluoranthene, and benzo(b)fluoranthene) recorded exceedances in 15.5%, 15.5%, and 26.87% of samples taken, respectively as well as their 95th percentile concentrations.

As the material was sampled and tested while stockpiled, prior to placement, specific locations of the exceedances within the placed soils cannot be determined, however, given the small number of exceedances for most contaminants which are distributed throughout the stockpiles sampled, the spatial distribution within the phase is unlikely to be localised or present a significant risk to Controlled Waters.

The number of exceedances of cyanide, fluoranthene and benzo(b)fluoranthene are more significant. However, in mitigation it should be noted that actual concentrations of free cyanide, fluoranthene and benzo(b)fluoranthene in perched groundwater samples recovered from this Phase 5E1 area, were all less than the applied laboratory detection limits for these determinants. It is considered that the determinants are more bound than the modelling would suggest or the intermittent perched groundwater prevents the movement due to a lack of hydraulic continuity.

Exceedance tracking tables presented in **Appendix C** summarise the source of materials placed in each 25m grid square and the respective exceedances identified within each source. 25m grid squares are presented on RLL drawing reference 18669-RLE-22-XXX-DR-O-0346 in **Appendix A**.

These tables show that exceedances within source materials were dispersed within the fill materials placed and therefore use of statistical assessment is considered appropriate to assess their suitability for reuse.

Asbestos was identified within seven of the 201 soil samples tested at concentrations of <0.001% to 0.044%, as shown in the table below.

Tale 4.2b Summary of Asbestos Contamination encountered in the Fill Material.		
Location	Asbestos Type	Quantification (%w/w)
AL21-1	ACM debris	0.020
AQ30-1	Chrysotile (White) Asbestos	<0.001
W209C-3	NA	<0.001
AI30-2	NA	0.0018
S19-2	NA	<0.001
R160-1	Chrysotile	0.006
5E1-SV2	Chrysotile	0.044

The Institute of Occupational Medicine (IOM) risk assessment report for the reuse of soils containing asbestos at Llanwern (**Ref. 4**) states that Made Ground is suitable for reuse in residential areas if concentrations are less than 0.02% (200PPM) and 600mm of clean cover (soils with asbestos content <0.001%) is provided. The Made

Ground material will be 750mm below finished levels based on the proposed formation levels.

4.4 Formation Surface

Following consultation with the Senior Scientific Officer at Newport City Council (NCC) chemical sampling of formation surface was proposed as an addendum to the Remediation Strategy (**Ref 8**). The additional sampling was undertaken in accordance with the Remediation Strategy and, in addition to the pre-remediation testing, validation samples were collected to assess the contamination status of the formation surface.

A total of 26 chemical samples were taken following completion of the earthworks to assess the contamination status of the formation surface. The validation testing of the formation surface (750mm below final ground level) was compared against screening criteria for 40% Infiltration of incident rainfall for residential areas in accordance with the Remediation Strategy. Samples were tested for heavy metals, polycyclic aromatic hydrocarbons (PAH), total petroleum hydrocarbon (TPH), gasoline range organics (GROs), BTEX, pH, soil organic matter (SOM), ammoniacal nitrogen, cyanide, phenols and half of samples were also tested for asbestos. A summary of the laboratory chemical results is presented in **Appendix C**. Laboratory certificates are presented in **Appendix D**.

The samples were screened against the RLL Re-use Screening Criteria 40% Infiltration of Incident Rainfall for Residential Areas in accordance with the Remediation Strategy (**Ref. 5**). The following table summarises the exceedances, and the locations of exceedances are shown on RLL drawing reference 18669-RLE-23-XXX-DR-O-0442-P01 in **Appendix A**.

Table 4.3 Summary of exceedances of RLL Re-use Screening Criteria 40% Infiltration of Incident Rainfall for Residential Areas for the Surface Validation Samples (750mm Below Final Ground Level)

Contaminant	No. of samples exceeding	Selected Screening Value (mg/kg)	Exceedances Concentration Range (mg/kg)	Upper 95 th Percentile of surface validation samples (mg/kg)
Cyanide	1 of 26	2.313	5.1	2.1
Fluoranthene	7 of 26	7.614	8.1 - 13	10.75
Benzo(b)fluoranthene	14 of 26	3.914	4 - 8	7.9

The formation surface material is 750mm below final ground levels to facilitate the provision of clean cover and appropriate construction material. As such, there is no viable pathway between the limited residual exceedances in the Made Ground and the proposed end users with addition of the imported clean cover in accordance with the Remediation Strategy.

All of the 26 samples submitted for laboratory analysis were screened for asbestos identification. One sample (5E1-SV2 at 0.20m) returned a positive result of 0.44%w/w chrysotile. The location was resampled and 4 additional samples around the original result were tested and the results recorded no detection of asbestos.

4.5 Soils Contamination Summary

Exceedances of cyanide, ammoniacal nitrogen, heavy metals and PAHs were encountered in a limited number of samples taken from the fill material samples when compared to the RLL Criteria '40% infiltration of Incident Rainfall for a Residential end-use'.

However, using the upper 95th percentile concentration of the testing the majority of these values are suitably lower than their respective calculated re-use criteria. The 95th percentile value records exceedances for cyanide, fluoranthene, and benzo(b)fluoranthene, although in mitigation, it should be noted that actual concentrations of free cyanide, fluoranthene and benzo(b)fluoranthene in perched groundwater samples recovered from this Phase 5E1 area, were all less than the applied laboratory detection limits for these determinants. It is considered that the determinants are more bound than the modelling would suggest or the intermittent perched groundwater prevents the movement due to a lack of hydraulic continuity.

Phase 5E1 currently does not have any adjacent watercourses, however within the proposed development (Drawing 8111-08-A011) Kings Wall Reen, which is yet to be formed, shall be approximately 5m to the north of the site. Material has been selectively positioned based on its contamination profile, in particular the benzo(b)fluoranthene and ammoniacal nitrogen. A sensitivity analysis for ammoniacal nitrogen was undertaken within the CWDQRA (**Ref. 5**) recommending that isolated exceedances could not be reused within 30m of the proposed surface water. As discussed in the Phase 5E1 DQRA (**Ref. 6**) materials containing PAH concentrations in excess of the calculated reuse criteria for 40% infiltration scenario and are designated to be used within areas of the development proposed for residential and commercial reuse; then this material should, as a precaution, be placed no closer than 150m-200m from the surface water reens into which infiltrated waters are likely to discharge. It is worth noting that the site does not have a connection to a controlled water.

Further assessment of the potential for impacts on the adjacent water courses undertaken in Section 6.2 to assess discrepancies in actual groundwater concentrations recorded compared to calculated values based upon soils analyses data. This suggests that specific determinands are not being mobilised as readily as the calculations suggest, or that significant contaminant attenuation is subsequently taking place within the Made Ground if these contaminants have become mobilised into local porewaters.

The remainder of the Site is more than the modelled ammoniacal nitrogen 30m distance to a proposed surface water feature, as such, the material which includes slight exceedances of the critical value is considered suitable for reuse beneath suitable clean cover.

Asbestos was identified within seven of the 201 fill material soil samples tested, at concentrations of between <0.001% and 0.044%. The only exceedance has been removed from the site and the location resampled. The retained material has concentrations of less than 0.02% (200PPM), the material is considered suitable for reuse in residential areas beneath suitable inert clean cover, in accordance with the IOM risk assessment report (**Ref. 3**).

5.0 Ground Gas Assessment

5.1 Gas Monitoring

Gas monitoring was undertaken in six monitoring wells (5E1-WS1, 5E1-WS3, and 5E1-WS5 to 5E1-WS8) between September and October 2022 by RLL. The locations of the monitoring wells are shown on RLL drawing 18669-RLL-22-XX-DR-O-0326 (**Appendix A**), and the monitoring results are available in **Appendix E**.

Six rounds of ground gas monitoring have been undertaken at locations installed between September and October 2022. A maximum concentration of methane of 3.4% was recorded, and a maximum concentration of 0.1% for carbon dioxide was recorded. The maximum initial gas flow rate recorded was 0.2l/hr in two locations.

A summary of the gas monitoring is presented in the table below.

Table 5.1 Gas Monitoring Results Summary					
Hole ID	Barometric Pressure (mb)	Peak Methane (%)	Peak Carbon Dioxide (%)	Min Oxygen (%)	Maximum Flow Rate (l/hr)
5E1-WS1	1005-1021	0.3-0.4	0.0-0.1	0.2-2.5	0.0
5E1-WS3	1004-1021	0.2-0.8	0.0-0.1	0.5-16.9	0.1
5E1-WS5	1004-1021	0.2-0.4	0.0-0.1	0.2-7.1	0.2
5E1-WS6	1005-1021	0.6-1.6	0.0-0.1	0.4-10.1	0.0
5E1-WS7	1005-1021	2.3-3.4	0.0-0.1	0.1-1.2	0.2
5E1-WS8	1005-1021	0.2-2.4	0.0-0.1	0.3-5.8	0.0

GSVs were calculated for each monitoring borehole and are initially conservatively based on the peak methane and carbon dioxide readings and the maximum flow rate encountered within each exploratory hole.

Table 5.2 Gas Screening Values						
Hole ID	Max. CO ₂ conc. (%)*	Max. CH ₄ conc. (%)	Steady. Flow Rate (l/hr)**	CO ₂ GSV	CH ₄ GSV	Borehole Characterisation
5E1-WS1	0.1	0.4	0.3	0.0003	0.0012	CS1
5E1-WS3	0.1	0.8	0.3	0.0003	0.0024	CS1
5E1-WS5	0.1	0.4	0.3	0.0003	0.0012	CS1
5E1-WS6	0.1	1.6	0.3	0.0003	0.0048	CS2
5E1-WS7	0.1	3.4	0.3	0.0003	0.0102	CS2

Table 5.2 Gas Screening Values						
Hole ID	Max. CO ₂ conc. (%)*	Max. CH ₄ conc. (%)	Steady. Flow Rate (l/hr)**	CO ₂ GSV	CH ₄ GSV	Borehole Characterisation
5E1-WS8	0.1	0.4	0.3	0.0003	0.0012	CS1

*0.1% concentration value has been used on any value less than 0.1%, based on the gas analyser margin of error.

**0.3 l/hr flow has been used on any value less than 0.3 l/hr, based on the gas analyser margin of error.

In accordance with CIRIA C665, based on gas monitoring completed to date, Phase 5E1 would fall within Characteristic Situation 2 (CS2) classification (or Amber 1 in accordance with NHBC Standards).

5.2 Radon

Information presented on the Public Health England 'UK Maps of Radon' website indicates that the Site is located within an area where less than 1% of homes are above the Action Level, therefore radon protection measures are not required.

6.0 Controlled Waters Validation

6.1 Controlled Waters Risk Assessment

The risk to Controlled Waters was assessed for the wider Llanwern development as part of the RLL CWDQRA (**Ref. 5**). The aim of the wider site CWDQRA was to derive soil re-use criteria to enable an assessment to be made as to the suitability of materials to be re-used on-site based on the risk they present to controlled waters. For the purposes of the assessment, Monks Ditch was considered to be the controlled waters receptor on the basis that the proposed drainage strategy for the Site requires discharge to Monks Ditch. This assessment utilised site specific data taken from the wider development but did not include data from within the Site (Phase 5E1).

The Phase 5E1 CWDQRA Addendum was submitted in 2023 by RLL (**Ref. 6**), was prepared in order to assess the suitability of the use of the reuse criteria derived as part of the site wide CWDQRA (**Ref. 5**) within the Site.

Following completion of the RLL CWDQRA, the Phase 5E1 Remediation Strategy was prepared (**Ref. 4**). The Site was sampled on a 25m grid (where access was not restricted) to assess material suitability for retention in accordance with the Remediation Strategy. Removal of unsuitable material and turnover of retained existing made ground as detailed in the Earthworks Specification and Remediation Strategy was required to mitigate the risks and prepare a reengineered plot with reduced permeability. Phase 5E1 remediation comprised the full turnover of Made Ground, removal of recorded contamination, removal of material with visual and olfactory evidence of contamination, the removal of buried obstructions and the use of clean cover as outlined in the RLL Remediation Strategy.

A CWDQRA Validation Plan was written by RLL in June 2022 following consultation with Natural Resources Wales as an addendum to the Remediation Strategy, in order to confirm additional validation information to be collected and set out a contingency plan (**Ref. 6**).

6.2 Controlled Waters Validation Summary

In October 2022, controlled waters validation works were undertaken by RLL, comprising falling head tests and sampling of the perched water for chemical analysis in accordance with the RLL CWDQRA Validation Plan (**Ref. 6**). The location of the monitoring wells and falling head tests are shown on RLL drawing 18669-RLL-22-XX-DR-O-0326 (**Appendix A**).

The RLL CWDQRA Validation Plan (**Ref. 6**) states that water monitoring positions are required to be retained for longer term monitoring. Water monitoring wells have been positioned in advance of a housing layout being approved, these positions shall be retained for as long as reasonably practicable with liaison the forward developer. If these wells are to be lost, boreholes shall be re-installed in longer term positions (public open space areas for example) that can be serviced and monitored by the Client's Engineer.

6.2.1 Perched Water Monitoring

Perched water levels following the earthworks on site, prior to validation testing or sampling encountered during the validation works is presented in the following table.

Table 6.1 Initial Groundwater Levels Summary				
Hole ID	Depth to perched water (m)	Depth to base of Borehole (m)	Strata	Remarks
5e1-WS1	2.1	2.89	Made Ground	Described as: clear to light brown, with medium suspended solids (silt).
5e1-WS3	2.52	3.31	Made Ground	Described as: dark brown, with high suspended solids (silt).
5e1-WS5	3.04	4.22	Made Ground	Described as: orangish brown with high suspended solids (silt), light sheen noted.
5e1-WS6	3.63	4.35	Made Ground	Described as: clear to light brown, with low suspended solids (silt)
5e1-WS7	3.22	3.86	Made Ground	Described as: light brown with low to medium suspended solids (silt)
5e1-WS8	DRY	2.38	Made Ground	N/A

The location of the monitoring wells are shown on RLL drawing 18669-RLL-22-XX-DR-O-0326 (**Appendix A**).

6.2.2 Perched Groundwater Monitoring

A total of eleven perched water samples have been obtained between October 2022 and June 2023; these were taken from the existing 5E1 window sample boreholes. The location of the monitoring wells are shown on RLL drawing 18669-RLL-22-XX-DR-O-0326 (**Appendix A**). A summary of the laboratory chemical results is presented in **Appendix F**, and laboratory certificates are presented in **Appendix G**. During the sampling round in October, due to a lack of perched water, sampling was only achievable in 5 of the 8 locations.

Samples were analysed for concentrations of metals, free cyanide, phenols, BOD/COD, TPH-CWG, BTEX, PAHs, VOC/SVOCs, ammoniacal nitrogen, sulphate and pH outlined in the RLL Remediation Strategy. The results were compared to pore water concentrations derived within the CWDQRA, as outlined in the RLL CWDQRA Validation Plan, presented in Table 1 where available as outlined in the RLL Remediation Strategy.

No contaminants were found to exceed the relevant RLL CWDQRA Validation Plan average pore water concentration values from samples analysed in Phase 5E1.

Average, 95th Percentile and Maximum concentrations from the water sampling were compared against the relevant RLL CWDQRA Validation Plan pore water concentration values for the selected Contaminants of Concern (iron, manganese, vanadium, benzo(a)pyrene, benzo(b)fluoranthene and naphthalene) and are

summarised in the following table. More detailed information is available about the Contaminants of Concern is available in the RLL CWDQRA Validation Plan

The 95th percentile CWDQRA concentrations comprise the calculated pore water concentrations used as initial concentrations ('at plume core') based on 95th percentile soil concentrations from sitewide ground investigations within the modelling undertaken as part of the RLL 2019 CWDQRA.

Table 6.2 - Summary of CWDQRA Pore Water Pressure Concentrations for perched groundwater

Contaminant	Average CWDQRA critical Value (µg/l)	Average concentration (µg/l)	Upper 95 th Percentile CWDQRA critical Value (µg/l)	Upper 95 th Percentile Concentration (µg/l)	Maximum CWDQRA Value (µg/l)	Maximum Concentration (µg/l)
Iron	113570	422.8	314670	1580	2949270	2400
Manganese	12000	27.25	44700	106.65	566000	310.3
Vanadium	970	45	3010	93.5	13498	140
Naphthalene	231	4.57	165	17	128680	22
Benzo[b]fluoranthene	76.7	< 0.1	280	< 0.1	2077	< 0.1
Benzo[a]pyrene	0.285	< 0.1	1.13	< 0.1	70	< 0.1

No results were recorded above the upper 95th percentile pore water concentration values (**Ref. 6**).

Typically concentrations have been shown to either remain comparable or be reducing during the monitoring period for the majority of contaminants.

Further assessment was undertaken to establish if the concentrations of the determinands not listed as a Contaminant of Concern represented a risk to Controlled Waters by undertaking modelling of select contaminants to determine the effect of subsurface attenuation. Calculations considered the standard EQS values, in relation to relative mobility, availability of published data in relation to fate and transport and the relative magnitude and trend in concentrations recorded over this period. As a result, a site specific Cgw Critical Criteria was derived and compared to the perched water samples, as shown in **Appendix F**, and in the table below.

Table 6.3 - Site specific Critical Criteria for determinands not considered a 'Contaminant of Concern'			
Contaminant	Cgw critical Value (µg/l)	Concentration Range (µg/l)	Upper 95 th Percentile Concentration (µg/l)
Arsenic	21,500	2.5 – 71	59.5
Cadmium	100	<1	N/A
Chromium	2,020	0.6 – 13	11
Copper	430	0.5 – 31	19
Lead	520	0.6 – 11	8
Mercury	30	0.1 – 0.3	0.3
Nickel	1,720	6.3 – 57	39.7
Selenium	430	2.6 – 15	13
Zinc	469	2.7 – 150	75
Ammoniacal Nitrogen	130,000	900 – 18,000	15,900
Cyanide	430	<50 – 200	100
TPH Aliphatic >C5-C6	4,300	<0.1	N/A
TPH Aliphatic >C6-C8	4,300	<0.1	N/A
TPH Aliphatic >C8-C10	4,300	<0.1	N/A
TPH Aliphatic >C10-C12	4,300	<0.1	N/A
TPH Aliphatic >C12-C16	4,300	<0.1	N/A
TPH Aliphatic >C16-C21	4,300	<0.1	N/A
TPH Aliphatic >C21-C35	4,300	<0.1	N/A

Table 6.3 - Site specific Critical Criteria for determinands not considered a 'Contaminant of Concern'

Contaminant	Cgw critical Value (µg/l)	Concentration Range (µg/l)	Upper 95 th Percentile Concentration (µg/l)
TPH Aliphatic >C35-C44	4,300	<0.1	N/A
TPH Aromatic >C5-C7	4,300	<0.1	N/A
TPH Aromatic >C7-C8	32,000	<0.1	N/A
TPH Aromatic >C8-C10	4,300	<0.1	N/A
TPH Aromatic >C10-C12	4,300	<0.1	N/A
TPH Aromatic >C12-C16	4,300	<0.1	N/A
TPH Aromatic >C16-C21	4,300	<0.1	N/A
TPH Aromatic >C21-C35	4,300	<0.1	N/A
TPH Aromatic >C35-C44	4,300	<0.1	N/A
TPH Aromatic >C40-C44	4,300	<0.1	N/A
Acenaphthene	43	<0.1	N/A
Acenaphthylene	43	<0.1 – 3.2	3.2
Anthracene	43	<0.1	N/A
Benzo(a)anthracene	43	<0.1	N/A
Benzo(k)fluoranthene	0.07*	<0.1	N/A
Benzo(g,h,i)perylene	0.07*	<0.1	N/A
Chrysene	43	<0.1	N/A
Dibenz(a,h)anthracene	43.09	<0.1	N/A

Table 6.3 - Site specific Critical Criteria for determinands not considered a 'Contaminant of Concern'			
Contaminant	Cgw critical Value (µg/l)	Concentration Range (µg/l)	Upper 95 th Percentile Concentration (µg/l)
Indeno(1,2,3-cd)pyrene	0.07*	<0.1	N/A
Fluoranthene	3	<0.1	N/A
Fluorene	43	<0.1 – 1.2	1.2
Phenanthrene	43	<0.1 – 1.1	1.1
Pyrene	43	<0.1	N/A

Notes: *Derived critical value lower than Laboratory Limit of Detection.

No results were recorded above the upper 95th percentile Cgw Critical Criteria concentration values.

Long term monitoring is intended to continue in existing locations that can be retained or at least 3 locations within or at the boundary of Phase 5E1. In accordance with the Remediation Strategy the long term monitoring is continue as the development progresses.

6.2.3 Falling Head Tests

Falling head tests were undertaken in eleven locations (5E1-FH1 to 5E1-FH11) Phase 5E1 in October 2022 and in 9 locations (5E1-INF-1 to 5E1-INF-9) in August 2023.

A 270mm diameter and 500mm high metal pipe was keyed in the ground approximately 25mm, a second 100mm pipe was keyed into the Made Ground within the larger pipe. The outside circumference of both pipes was sealed with natural clay and the pipes covered with a plastic sheet.

The purpose of the second pipe is to reduce surface wetting and horizontal movement of water, the plastic sheet was placed to reduce evaporation and rainfall interfering with the test.

Both pipes were filled with approximately 100mm to 300mm of clean water and measurements were taken to the top of water from the top of the inner pipe to measure the permeability of the underlying soils. The test is non-standard but is intended to be consistently repeatable to provide site specific data as a line of evidence for the surface of the reengineered Made Ground to support the earthworks test results in assessing the permeability of the site in accordance with modelled parameters within the remediation strategy.

Falling head tests were conducted for a minimum of 130 minutes, by this period it was found that infiltration rates (measured in increments) had substantially settled and the rate is considered more representative of the ground conditions. Some infiltration tests were left for extended periods to allow for an extended dataset (up to 1510 minutes).

The location of the falling head tests are shown on RLL drawing 18669-RLL-22-XX-DR-O-0326 (**Appendix A**), and the raw data is available in **Appendix H**.

Table 6.4 Falling Head Test Results Summary

Test ID	Initial Water Level (mm)	Duration of Test (mins)	Final Water Level (mm)	Total Fall in Water Level (mm)	Permeability (m/s)
5e1-FH1	187	286	180	7	4.08E-07
5e1-FH2	193	259	191	2	1.29E-07
5e1-FH3	259	215	250	9	6.98E-07
5e1-FH4	290	255	275	15	9.80E-07
5e1-FH5	204	235	190	14	9.93E-07
5e1-FH6	104	260	89	15	9.62E-07
5e1-FH7	150	250	149	1	6.67E-08
5e1-FH8	221	130	217	4	5.13E-07
5e1-FH9	145	333	141	4	2.0E-07
5e1-FH10	190	330	185	5	2.53E-07
5e1-FH11	188	330	185	3	1.52E-07
5e1-INF-1	235	1510	149	86	9.49E-07
5e1-INF-2	212	1416	130	82	9.65E-07
5e1-INF-3	120	585	90	30	8.54E-07
5e1-INF-4	172	856	121	51	9.93E-07
5e1-INF-5	215	1335	140	75	9.36E-07
5e1-INF-6	177	1235	107	65	8.77E-07
5e1-INF-7	139	1302	69	70	8.96E-07
5e1-INF-8	154	1296	89	65	8.36E-07
5e1-INF-9	130	1292	92	37	4.77E-07

The Phase 5E1 CWDQRA (**Ref. 5**) assumed that permeability of the re-engineered ground on the site would be approximately 1E-07. The falling head tests indicated the permeability of the underlying soils to be very low, with an range of 9.93E-07m/s to 6.67E-08Em/s.

Based on the falling head test results the ground is considered to have poor drainage characteristics consistent with the modelling and in accordance with the remediation strategy.

6.3 Rising Head Tests

Five rising head tests were conducted on existing boreholes on the Site.

The rising head tests were designed and undertaken to broadly align with BS EN ISO 22282-2-2012. In advance of undertaking the tests, the boreholes were assessed as to whether they were suitable for undertaking a rising head test and an initial water level was measured. The wells were then purged until dry. Selected locations were then monitored as water levels returned towards equilibrium following an 'instantaneous' decrease in head.

A cross section showing the initial water levels of boreholes selected for rising head tests is shown on Drawing 18669-RLL-22-XX-DR-O-0326 (**Appendix A**). It is clear that there is no consistent water body on Site, indicating that the reengineered condition of the Site makes the CWDQRA (**Ref. 6**) model criteria extremely conservative.

A summary of the results is below:

Table 6.5– Rising Head Test Results Summary					
Test ID	Initial Water Level (mm)	Duration of Test (mins)	Final Water Level (mm)	Measured Rise in Water Level (mm)	Permeability (m/s)
5E1WS03	0.98	240	0.99	0.01	-1.96 E-07
5E1WS05	1.974	70	1.971	0.003	-5.55 E-07
5E1WS06	2.40	85	2.39	0.01	-8.54 E-07
5E1WS07	2.20	163	2.18	0.02	-5.12E-07
5E1WS03	2.001	145	2.006	0.005	-9.25E-07

The RLL DQCWRA (**Ref. 6**) assumed that permeability of the re-engineered ground on the Site would be approximately 1E-07. The rising head tests indicated the permeability of the underlying soils to be very low, with a range of -9.25 E-07m/s to -1.96 E-07Em/s.

Based on the rising head test results the ground is considered to have poor drainage characteristics consistent with the modelling and in accordance with the Remediation Strategy.

6.3.1 Development Materials

The provision of a piling mat to enable the construction of the foundations, as part of NRW requirements for the development, will be installed by the onward housebuilder. In accordance with infiltration rates described within Soil Mechanics

Principles and Practise, 3rd Edition (**Ref. 8**) the piling mat would typically comprise either Type 1 material (10^{-1} to 10^{-2}) or 6F2 recycled aggregate (10^{-3} to 10^{-5}) and depending on the weight of the rig would be approximately be 500mm thick. These construction materials have a typical permeability classed as very good to good drainage. However, if these materials were to have lower permeability, then infiltration would be further reduced when compared to the conditions modelled.

7.0 Conclusions

This report has been prepared pursuant to the partial discharge of Planning Condition 28 (P1 – pre construction stage) of the Outline Planning Permission Reference 06/0471 for the proposed development of residential development Phase 5E1 as part of a wider mixed use development at Llanwern, Newport.

During previous intrusive ground investigations on Phase 5E1, the Made Ground was found to contain exceedances of cyanide, heavy metals and PAHs; as well as numerous buried obstructions. As such, remediation works were required.

The remediation works were undertaken by McCarthy Contractors (Bridgend) Ltd between May and September 2022. The works comprised site clearance, removal of obstructions, removal of unsuitable material, excavation and turnover of the suitable for reuse Made Ground to the underlying Tidal Flat Deposits and re-engineering to a formation level of 750mm below the proposed final ground level to facilitate the provision of clean cover requirements.

During the removal of the Made Ground, numerous buried obstructions were encountered including piles and fused slag. The buried obstructions were removed in their entirety, or in the case of the deep piles, cropped to the top of the underlying Tidal Flat Deposits. The turnover of approximately 115,000m³ of Made Ground allowed for the surveying and chemical validation of the natural clay at the base of excavation. Approximately 60,000m³ of stockpiled site won suitable material and pre-classified material from the adjacent Phase 5E2 was imported to achieve the formation levels. The imported material was compliant with the onsite reuse criteria..

Following the removal and re-engineering of the Made Ground, the Site was assessed by an RLL engineer for visual and olfactory evidence of contamination. Validation of the remedial earthworks relevant to Phase 5E1 comprised chemical validation soil sampling, permeability testing, perched water sampling, gas monitoring and chemical sampling to assess the contamination status of the formation surface. The fill material used to re-engineer Phase 5E1 was predominantly granular, comprising sandy gravel with variable quantities of clay, silt and cobbles.

The reuse criteria presented in the Phase 5E1 CWDQRA (40% infiltration) (ref. 18669-RLL-23-XX-RP-O-0477-P01) is based on influent to the surface waters from perched water within the Made Ground. Therefore the 95th percentile soil concentration is relevant in terms of compliance as the infiltrated rainwater passes through the body of low permeability re-engineered material before it enters a surface water. The low permeability or poor drainage characteristics of the re-engineered site was recorded in the falling head test results. The perched water sampling from site indicated improved site conditions when compared with the assumed pore water concentrations in the 2019 RLL CWDQRA (ref. 18669-RLE-19-RP-O-0006-A).

Five soil samples were collected from the Tidal Flat Deposits exposed during the earthworks and sent for contamination testing. Two exceedances of the criteria was recorded for ammoniacal nitrogen.

Exceedances of cyanide, ammoniacal nitrogen, heavy metals and PAHs were encountered in a limited number of samples taken from the fill material samples when compared to the RLL Criteria '40% infiltration of Incident Rainfall for a Residential end-use'.

However, using the upper 95th percentile result of the testing, the majority of these values are suitably lower than their respective calculated re-use criteria. The 95th percentile value records exceedances for cyanide, fluoranthene, and benzo(b)fluoranthene.

Asbestos was identified within seven of the 201 fill material soil samples tested, at concentrations of between <0.001% and 0.044%. The only exceedance has been removed from the site and the location resampled. The retained material has concentrations of less than 0.02% (200PPM), the material is considered suitable for reuse in residential areas beneath suitable inert clean cover, in accordance with the IOM risk assessment report.

Phase 5E1 currently does not have any adjacent watercourses and the wider development does not have a connection to a controlled water. However within the proposed development Kings Wall Reen, which is yet to be formed, shall be approximately 5m to the north of the site. Material has been selectively positioned based on its contamination profile, in particular the benzo(b)fluoranthene and ammoniacal nitrogen. A sensitivity analysis was undertaken within the CWDQRA recommending that isolated exceedances of ammoniacal nitrogen could not be reused within 30m of the proposed surface water. As discussed in the Phase 5E1 DQRA (**Ref. 6**) materials containing PAH concentrations in excess of the calculated reuse criteria for 40% infiltration scenario and are designated to be used within areas of the development proposed for residential and commercial reuse; then this material should, as a precaution, be placed no closer than 150m-200m from the surface water reens into which infiltrated waters are likely to discharge.

A total of eleven perched water samples have been obtained between October 2022 and June 2023. No contaminants were found to exceed the relevant RLL CWDQRA Validation Plan average pore water concentration values for the Contaminants of Concern from samples analysed in Phase 5E1. Further assessment was undertaken to establish if the concentrations of the determinands not listed as a Contaminant of Concern represented a risk to Controlled Waters by undertaking modelling of select contaminants to determine the effect of subsurface attenuation. As a result, a Site specific Cgw Critical Criteria was derived and compared to the perched water samples. No results were recorded above the upper 95th percentile for either the pore water concentration values, nor the Site specific Cgw Critical Criteria. This suggests that specific determinands are not being mobilised as readily as the calculations suggest, or that significant contaminant attenuation is subsequently taking place within the Made Ground if these contaminants have become mobilised into local porewaters.

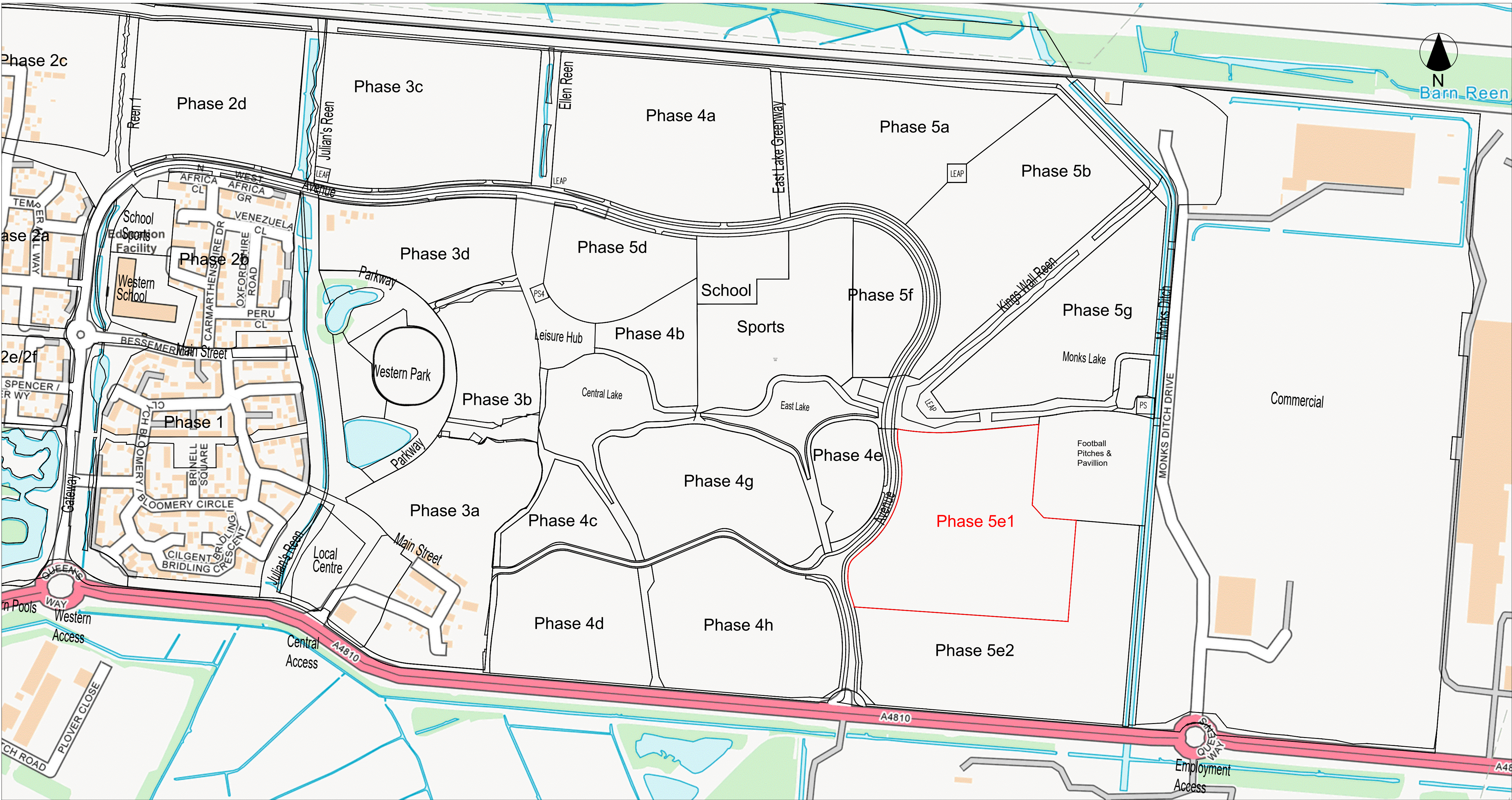
In accordance with CIRIA C665, based on recent gas monitoring, Phase 5E1 would fall under Characteristic Situation 2 (CS2) classification (or Amber 1 in accordance with NHBC Standards). Radon protection measures are not required.

The removal of contaminated material, the excavation to natural clay and the re-engineering of the Site has removed potential sources of contamination and has

reduced the permeability of the Made Ground. Made Ground assessed to be suitable for reuse beneath the clean cover (when compared with criteria presented in the RLL Remediation Strategy) was re-engineered and compacted in accordance with the RLL Earthworks Specification. The Site has been re-engineered to be 750mm below final formation levels to facilitate the provision of clean cover across the Site. The pathway between the residual exceedances in the Made Ground and the site end-users will be broken with the provision of the imported clean cover, in accordance with the RLL Remediation Strategy. The reduced permeability will inhibit infiltration and the proposed development will increase the proportion of rainwater intercepted and directly entering surface waters. Phase 5E1 is not presently adjacent to a surface water feature, however in the proposed development a re-en shall be present 5m to the north of the site. The low to very low permeability of the re-engineered Made Ground (in the range of E-07m/s to E-08m/s) combined with the addition of a minimum of 600mm clean cover reduces the residual risk to controlled waters and human health.

Based on the site monitoring and validation information RLL consider that the remediation works at the Phase 5E1 Site have been undertaken in accordance with the requirements of the Phase 5E1 Remediation Strategy (ref. 18669-RLL-23-XX-RP-O-0474-P01).

Appendix A: Drawings



GENERAL NOTES

NO DIMENSIONS TO BE SCALED OFF THIS DRAWING.

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ALL LEVELS ARE IN METRES UNLESS NOTED OTHERWISE.

ANY DISCREPANCIES NOTED ON SITE ARE TO BE REPORTED TO THE ENGINEER IMMEDIATELY.

KEY:

Approximate Site Boundary

P02	10.05.23	Update	FT	NS
P01	27.10.21	First Draft	SR	CW
Rev	Date	Amendments	By	Chk



Client
St Modwen Developments

Project
P18-669 Llanwern

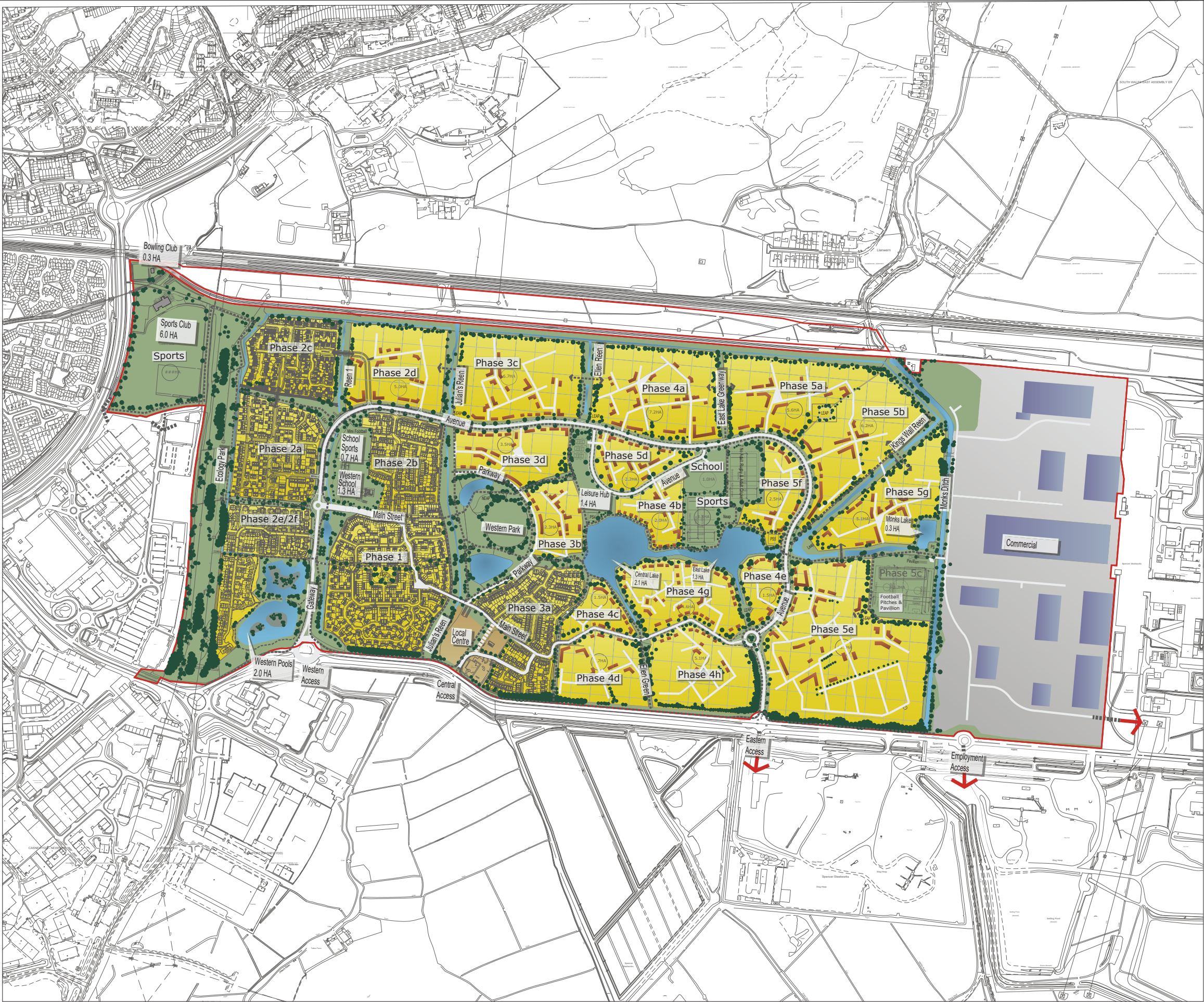
Drawing Title
Phase5e1
Site Location Plan

INFORMATION

Drawn	Checked	Date
1:1250 @ A1	FT	NS
10.05.23		
Drawing No.	Rev.	
18669-RLL-21-XX-DR-O-0173_P02		
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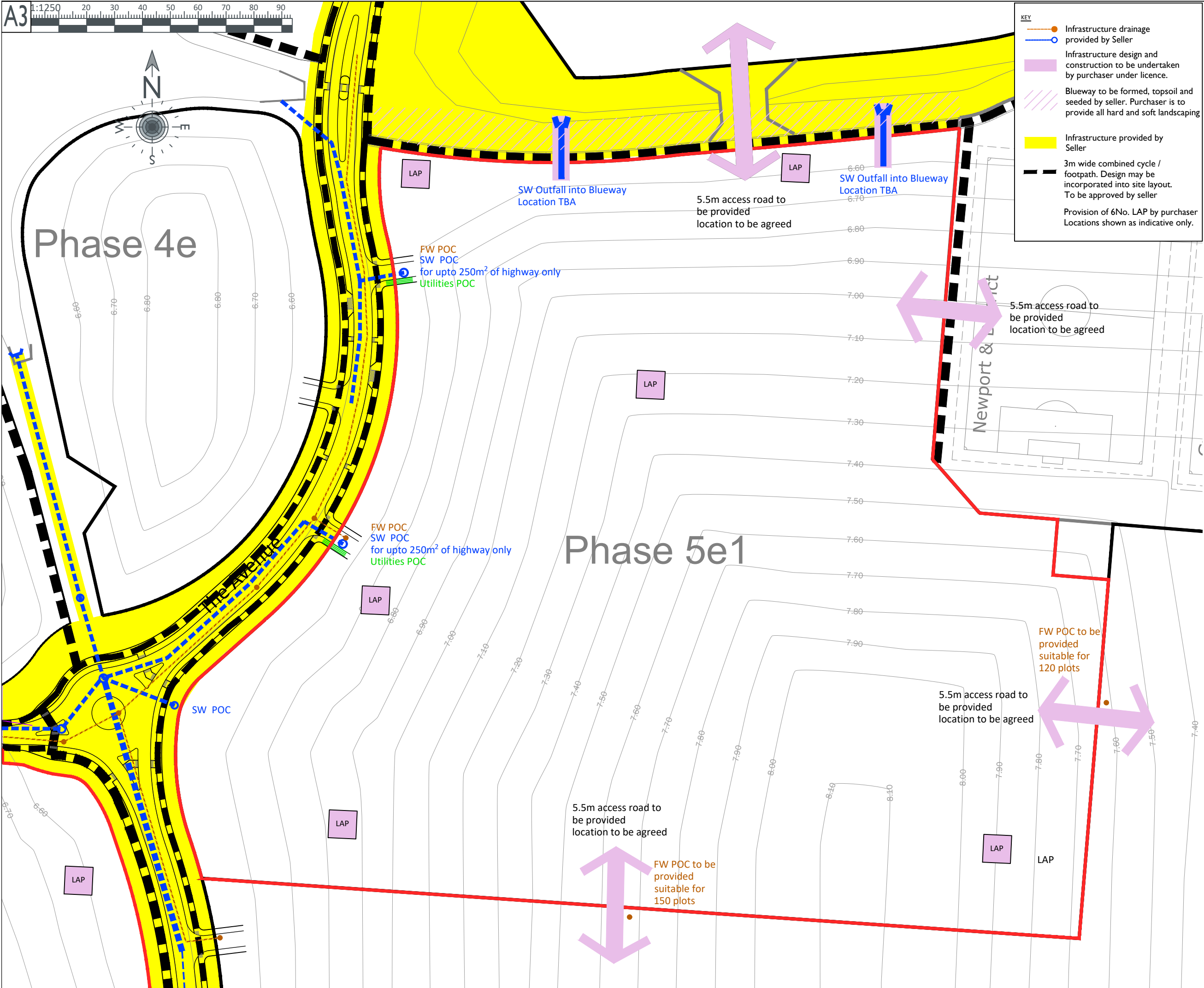
Glan Llyn -ESAMP Indicative Masterplan



Glan Llyn Residential Numbers (based on existing masterplan)					
Phase/Plot	Outlet	Area (HA)	Area (Acres)	Density (HA)	Total Units
1	Persimmon	9.77	24.15	31.4	307
2/a	Bellway	5.20	12.84	35	182
2/b	SMH	4.06	10.02	35	142
2/c	Bellway	4.30	10.62	35.3	152
2/d	Persimmon	4.98	12.30	35	174
2/e&f	SMH	5.10	12.61	29.8	152
1 and 2/Total		33.40	82.54		1109
3a		5.86	14.49	35	205
3b		2.32	5.74	35	81
3c		6.72	16.60	38.1	256
3d		3.45	8.53	35	121
3 Total		18.36	45.36		663
4a		7.19	17.78	34.8	250
4b		2.04	5.04	35	71
4c		1.53	3.78	35	54
4d		3.65	9.03	35	128
4e		1.49	3.68	35	52
4f		-	-	-	-
4g		4.64	11.46	35	162
4h		5.15	12.73	35	180
5a		5.65	13.95	35	198
5b		6.23	15.41	35	218
5c	Sports	2.67	6.60	35	93
5d		2.24	5.53	35	78
5e		13.72	33.90	35	480
5f		2.49	6.15	35	87
5g		5.06	12.50	35	177
4 and 5/Total		63.75	157.53		2230
1,2,3,4,5 Total		115.51	285.44		4002

NOTE: Areas and housing numbers assume that plot 5c sports is moved to CBP and converted to resi





NOTES
These drawings have been produced with reference to the CDM Regulations 2015. Please note that these are pre-construction phase drawings and should be subject to further design risk management as required in accordance with Regulation 9

- **Foul Drainage**
Seller to provide infrastructure drainage up to Foul POC
- **Surface Water Drainage**
Seller to provide infrastructure drainage as shown
Purchasers' SW to design with consideration for submerged outfall up to 4.65m AOD water level.
- **Utilities**
Utility point of connection to be agreed with Purchaser.
- **Levels**
Minimum Finished Development level 6.50m AOD. Contour levels indicated are finished ground levels, the site will be prepared to formation levels, approx. 750mm below FGL.
Refer to As-Built survey for level info.
Tolerance on levels + - 50mm.
Refer to Atkins specification regarding maximum development levels
- **Entrances / Pedestrian links**
Location to suit Purchasers site layout, to be in accordance with Glan Llyn Western Sub-Area masterplan.
- **Site Infrastructure**
The design and construction of all infrastructure outside of phase boundary is to be approved by the seller and relevant adopting authorities. The seller will assume maintenance responsibility for all culverts and headwalls.

REV	DATE	REVISION NOTE	BY

REV	DATE	REVISION NOTE	BY

CLIENT

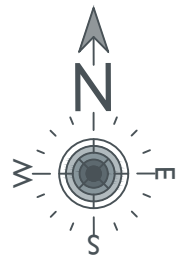
St. Modwen Developments

PROJECT
Llanwrn
Newport

DRAWING TITLE
Phase 5e1
Engineering Constraints

DRAWING ISSUE STATUS
INFORMATION
PJA JOB No. SUB-CODE DRAWING NO. REVISION
02554 - F - 5e110 - P0
Revision Letter : P - Prelim / A - Approval / T - Tender / C - Construction
BIM DRAWING REFERENCE

SCALE	DRAWN	REVIEWED	DATE
A3@1:1250	GH	DMcC	04.01.21



NOTES

These drawings have been produced with reference to the CDM Regulations 2015. Please note that these are pre-construction phase drawings and should be subject to further design risk management as required in accordance with Regulation 9

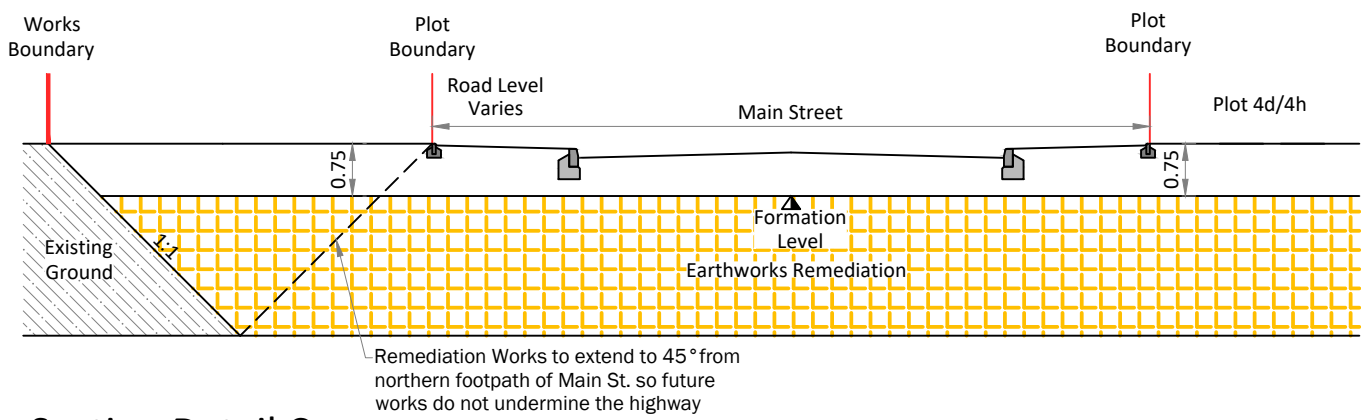
1. Contours shown represent formation level which is 750mm from finished ground levels.

KEY

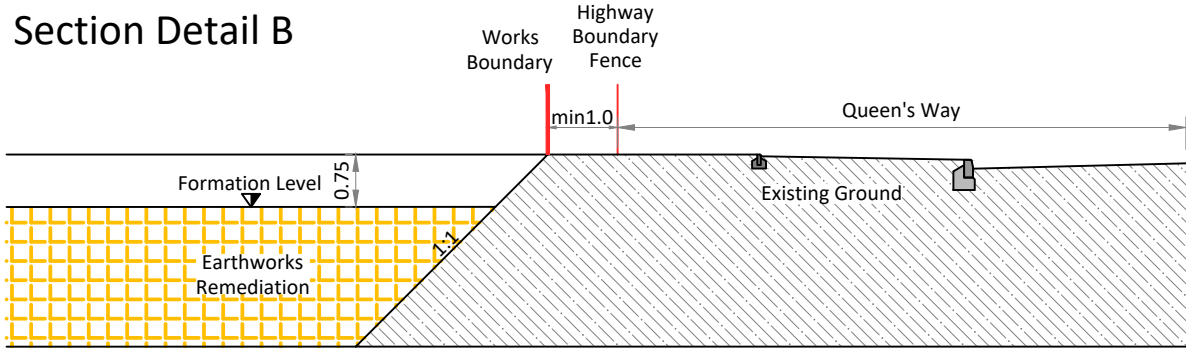
Works Boundary

Plot Boundary

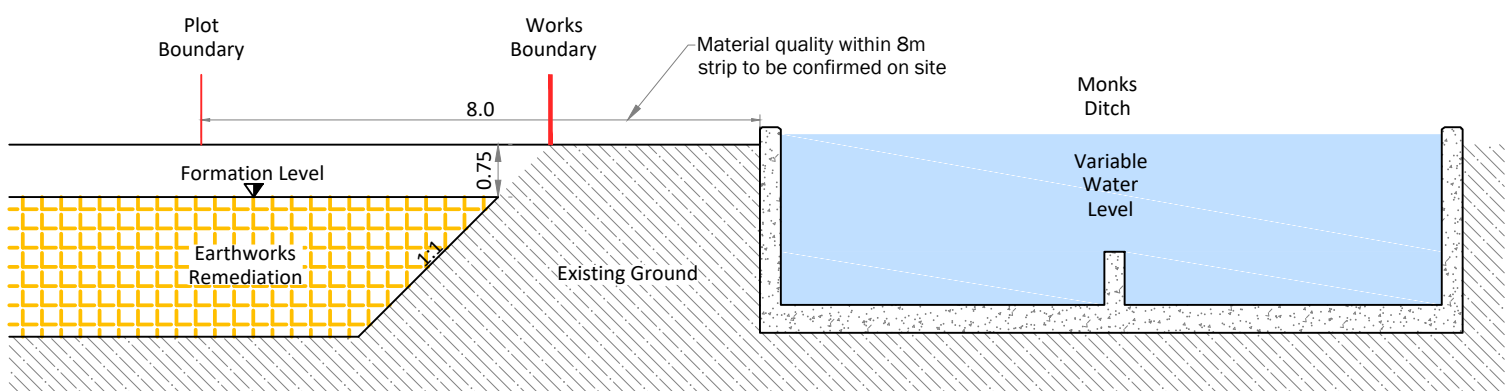
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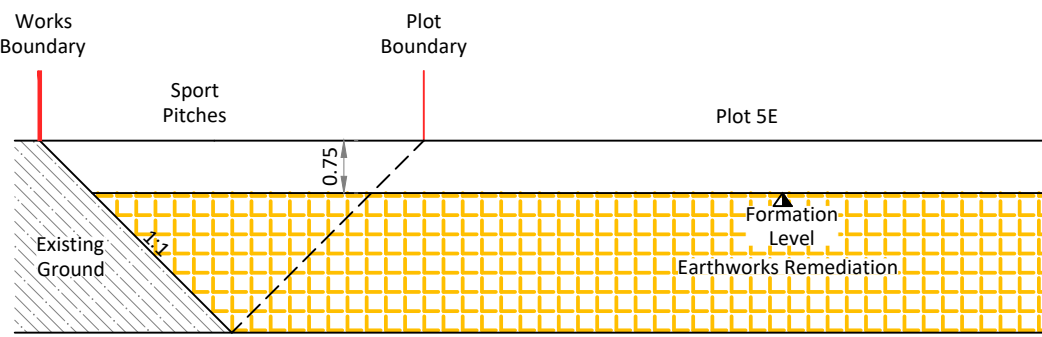
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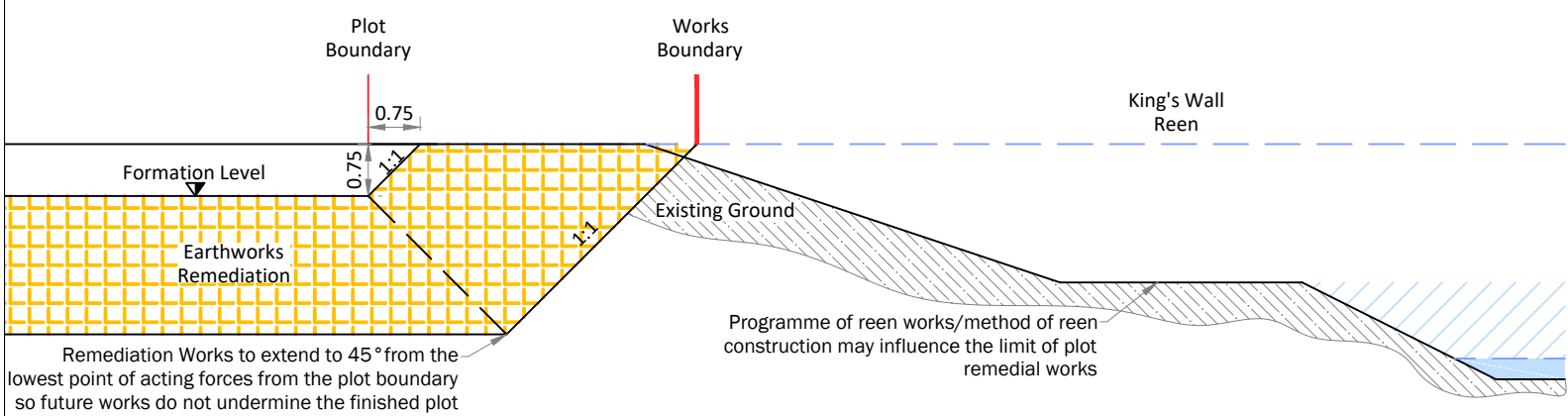
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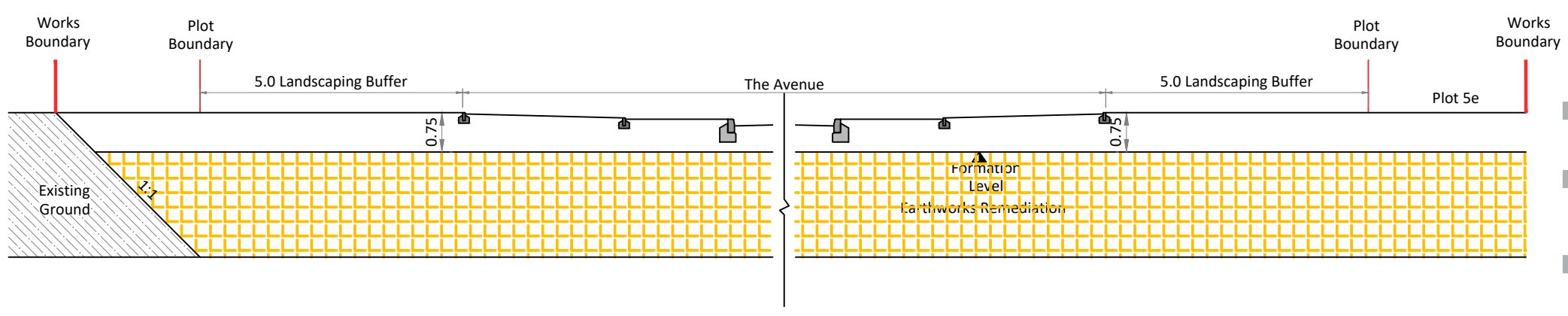
Section Detail D



Section Detail E



Section Detail F



REV	DATE	REVISION NOTE	BY
-----	------	---------------	----

PJA

Seven House - High Street
Longbridge - Birmingham
B31 2UQ - Tel: 0121 475 0234

Birmingham - Bristol
Exeter - London - Reading
pja.co.uk

CLIENT

St. Modwen Development

PROJECT

Llanwern
Newport

DRAWING TITLE

Formation Works
Tie-in Sections

DRAWING ISSUE STATUS

INFORMATION

PJA JOB No. SUB-CODE DRAWING NO. REVISION
02554 - EE - 0100 - P0

Revision Letter : P - Prelim / A - Approval / T - Tender / C - Construction
BIM DRAWING REFERENCE

SCALE DRAWN REVIEWED DATE
A2@As shown Gh DMcC 29/03/2021

NTS.



A	AS BUILT			MP	32/28/2022
REV	DESCRIPTION			BY	DATE

**McCarthy Contractors
(Bridgend) Ltd**

A66 Village Farm Industrial Estate
Pyle - CF33 6BP
Tel: (01656) 755838 Fax: (01656) 740596

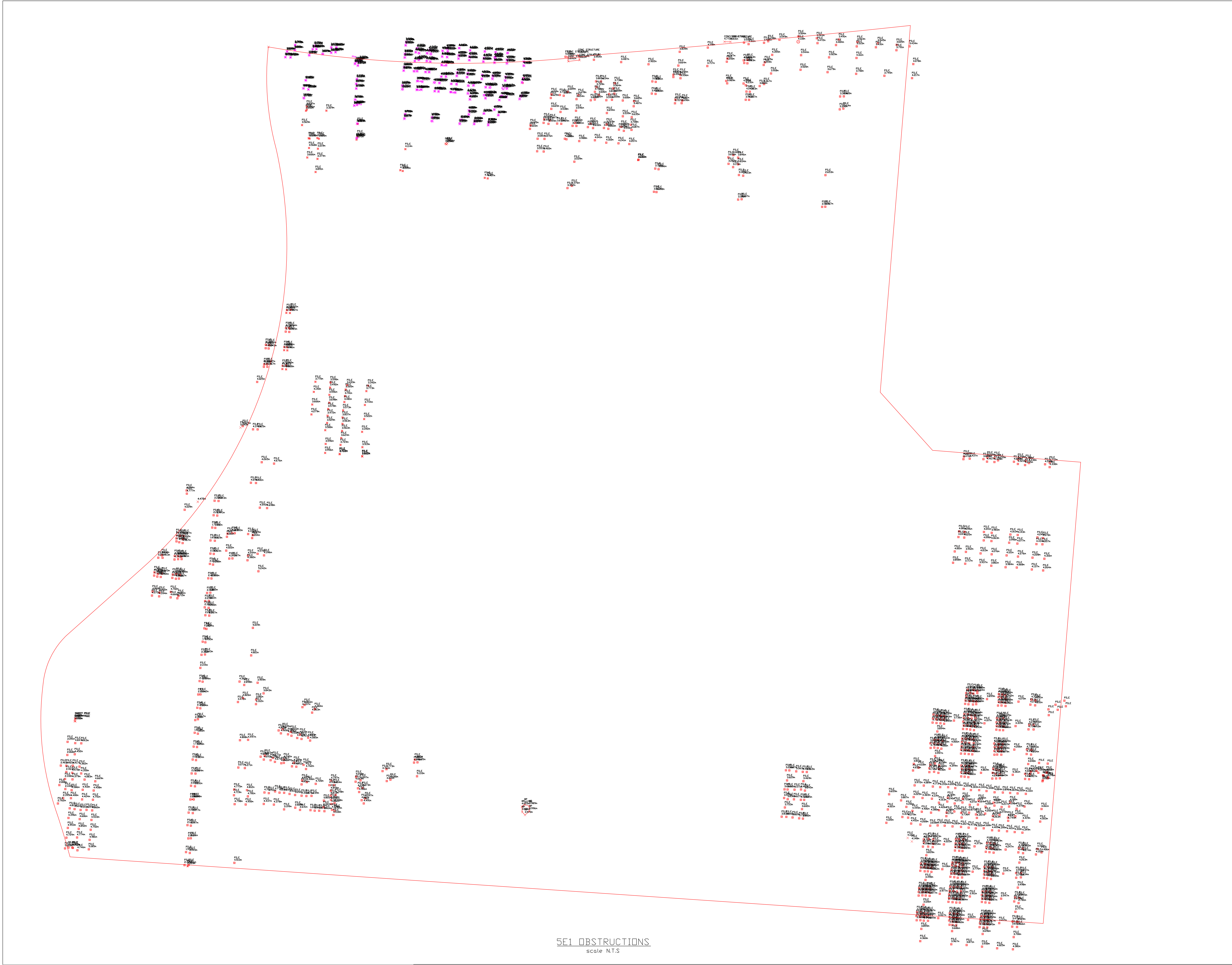
client **ST MODWENS**

project **LLANWERN**

drawing title **SE10 AS BUILT
FORMATION**

Drawn	Check	Clean	Issue
MP	-	N.T.S @A0	SEPT 2022

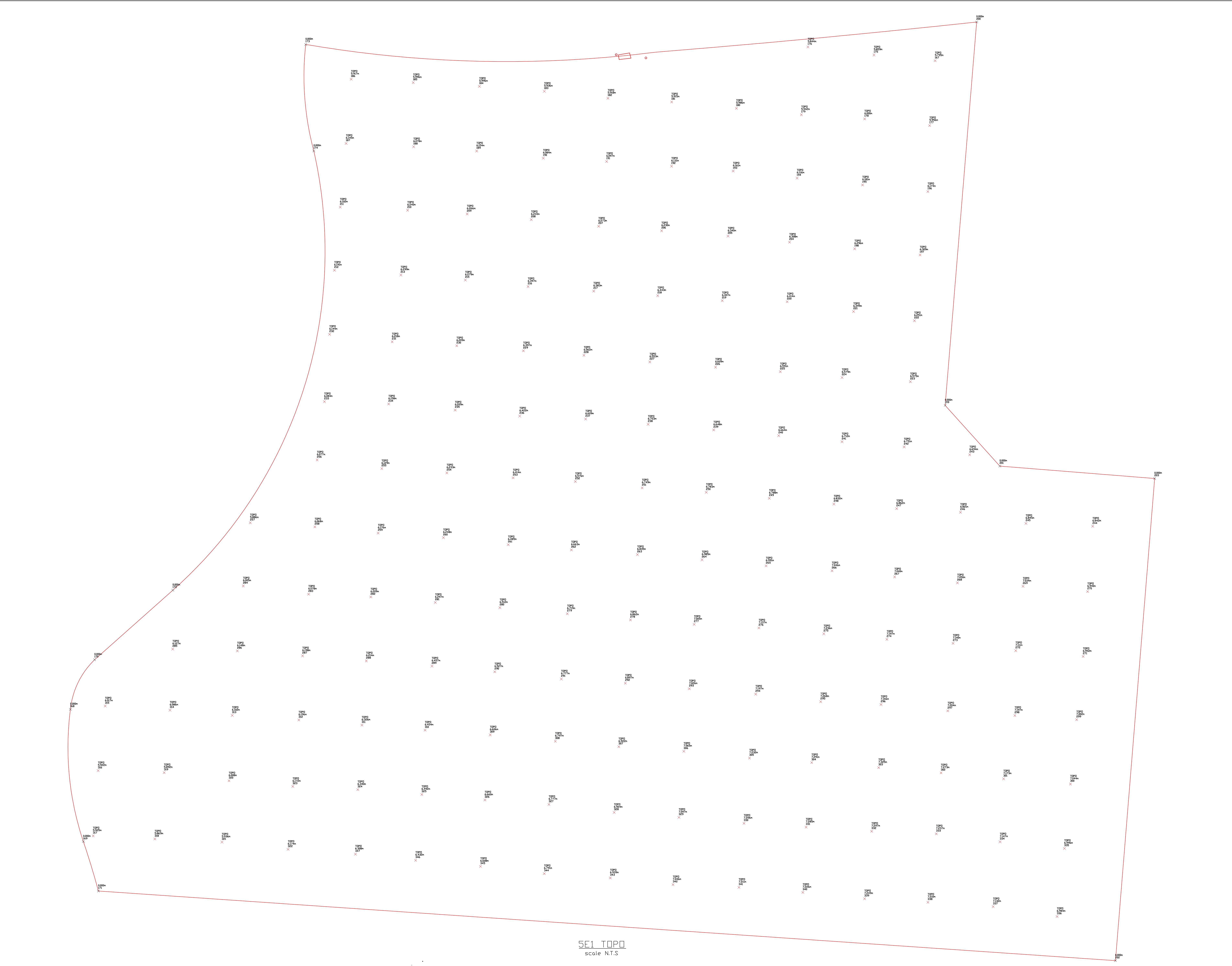
As Built	Job No.	Drawing No.	Rev.
☐ ☒ ☐			A



NOTES

1. Warning the survey details the As Built position of the structures as surveyed at formation level. No guarantee can be given to the position of the structure/obstruction or extent's underneath the formation layer

A		AS BUILT		MP	22/09/2022
REV	DESCRIPTION			BY	DATE
McCarthy Contractors (Bridgend) Ltd					
46A Village Farm Industrial Estate Pyle - CF33 6DP Tel - (01656) 745838 Fax - (01656) 745996					
client	ST MODWENS				
project	LLANWERN				
drawing title					
5E1 AS BUILT STRUCTURES/OBSTRUCTIONS					
drawn	check	drawn	check	date	
MP	-	N.T.S @A0		SEPT 2022	
As Built	☒	Job No	Drawing No		Rev
	☐				A



NOTES

1

AS BUILT	MP	21/09/2022
REV	DESCRIPTION	BY DATE

McCarthy Contractors
(Bridgend) Ltd

46A Village Farm Industrial Estate
Pyle - CF33 6BP
Tel - 016561 745838 Fax - 016561 744596

client

ST MODWENS

project

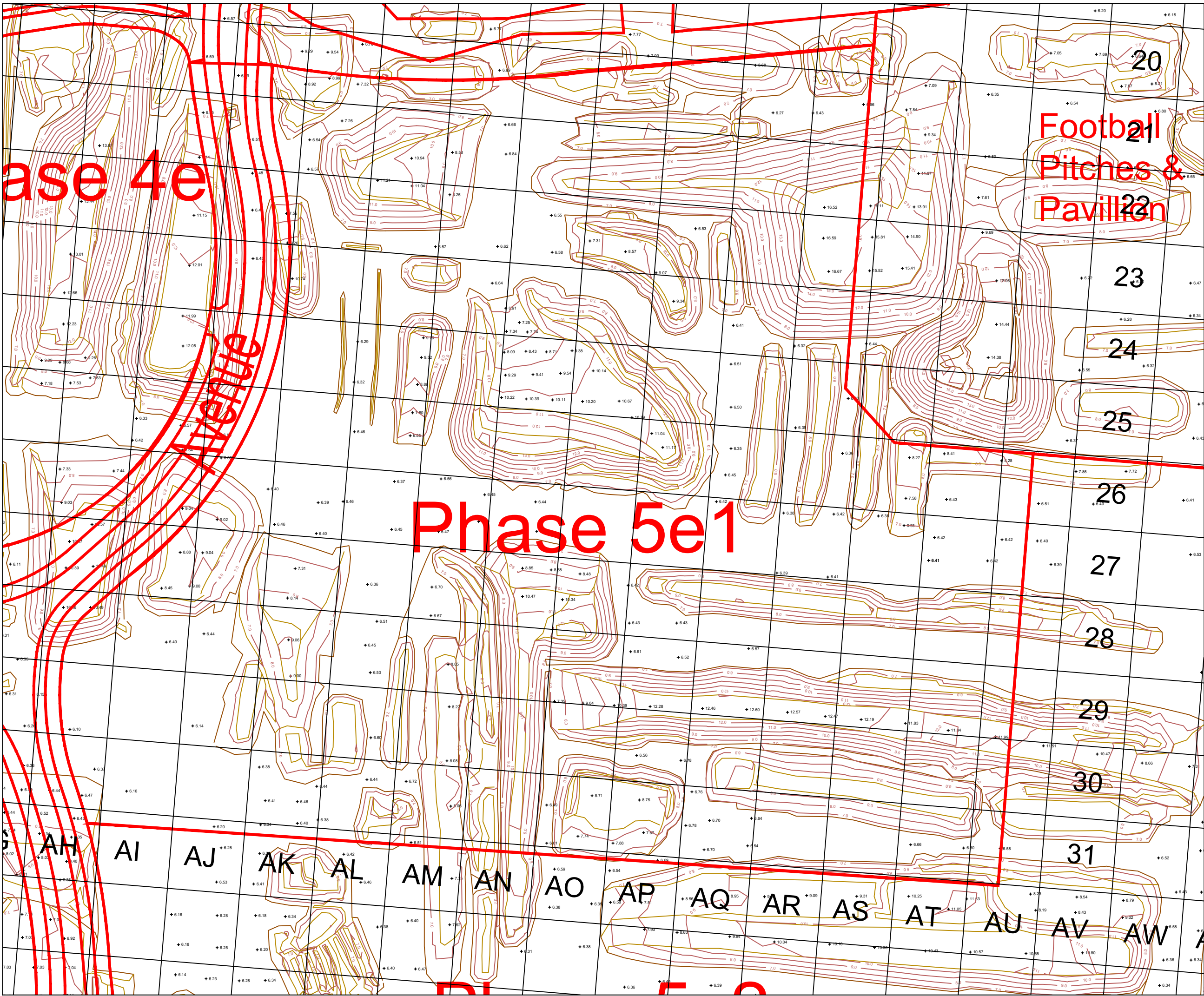
LLANWERN

drawing title

SE1 AS BUILT
TOPOGRAPHICAL SURVEY

Drawn	Check	Code	Date
MP	-	N.T.S.@A0	SEPT 2022

As Built	Job No	Drawing No	Rev
☐			A



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KEY:

- PHASE BOUNDARY
- GRID

Rev	Date	Amendments	By	Chk



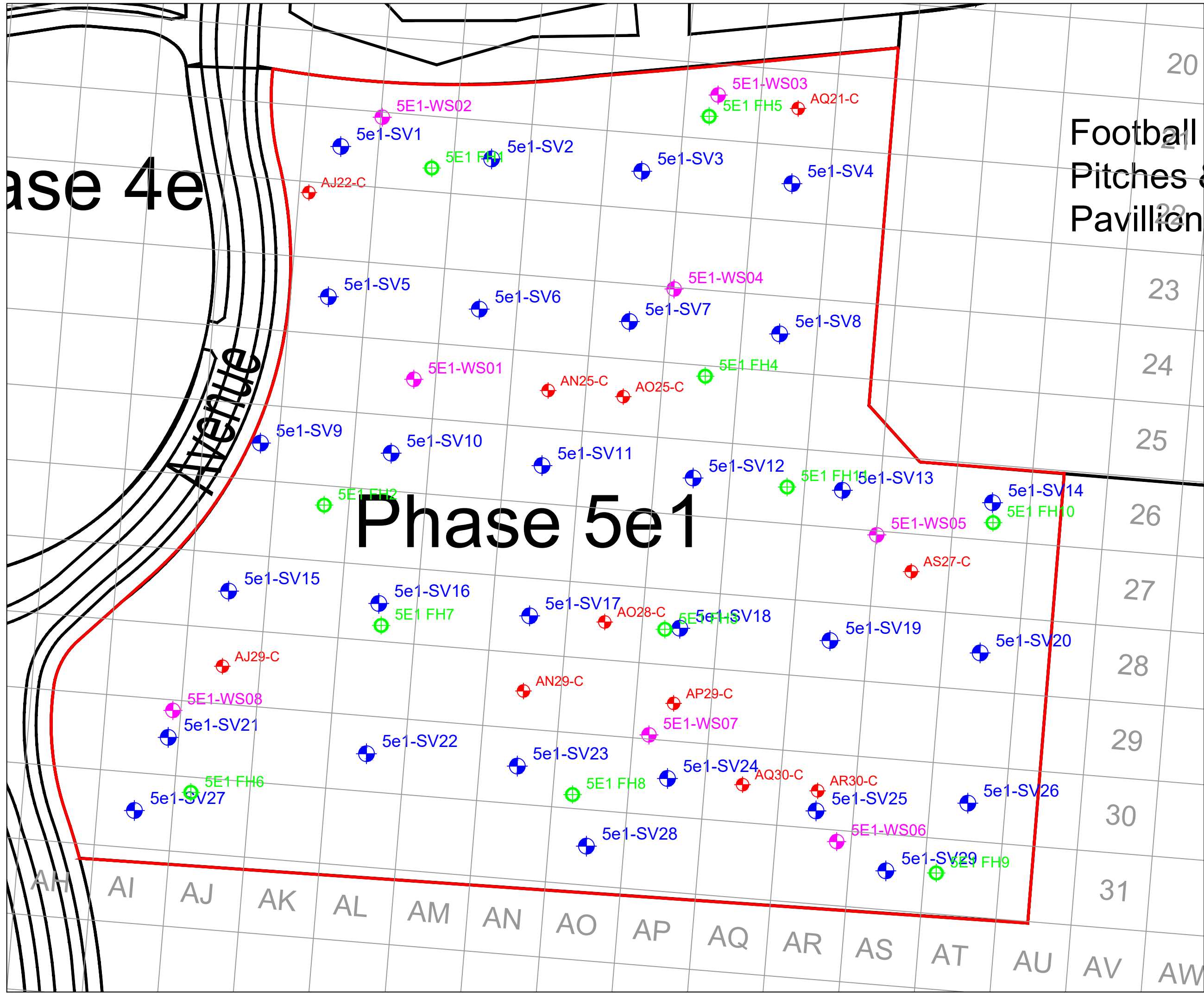
Client
ST Modewn Developments

Project
P18-669 Llanwern Reclamation

Drawing Title
5e1 Grid and Layout

INFORMATION

	Drawn	Checked	Date
NTS	SR	CW	26/10/22
Drawing No.			Rev.
18669-RLL-22-XX-DR-O-0346			
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KEY:

- 5E1-SV SURFACE VALIDATION SAMPLE LOCATION
- 5E1-C CLAY VALIDATION SAMPLE LOCATION
- FH4 FALLING HEAD TEST LOCATION
- WS WINDOW SAMPLE BOREHOLE LOCATION

C	01.11.22	Infiltration Tests Added	SR	CW
B	28/09/2022	Updated surface validation locations	CD	CW
Rev	Date	Amendments	By	Chk



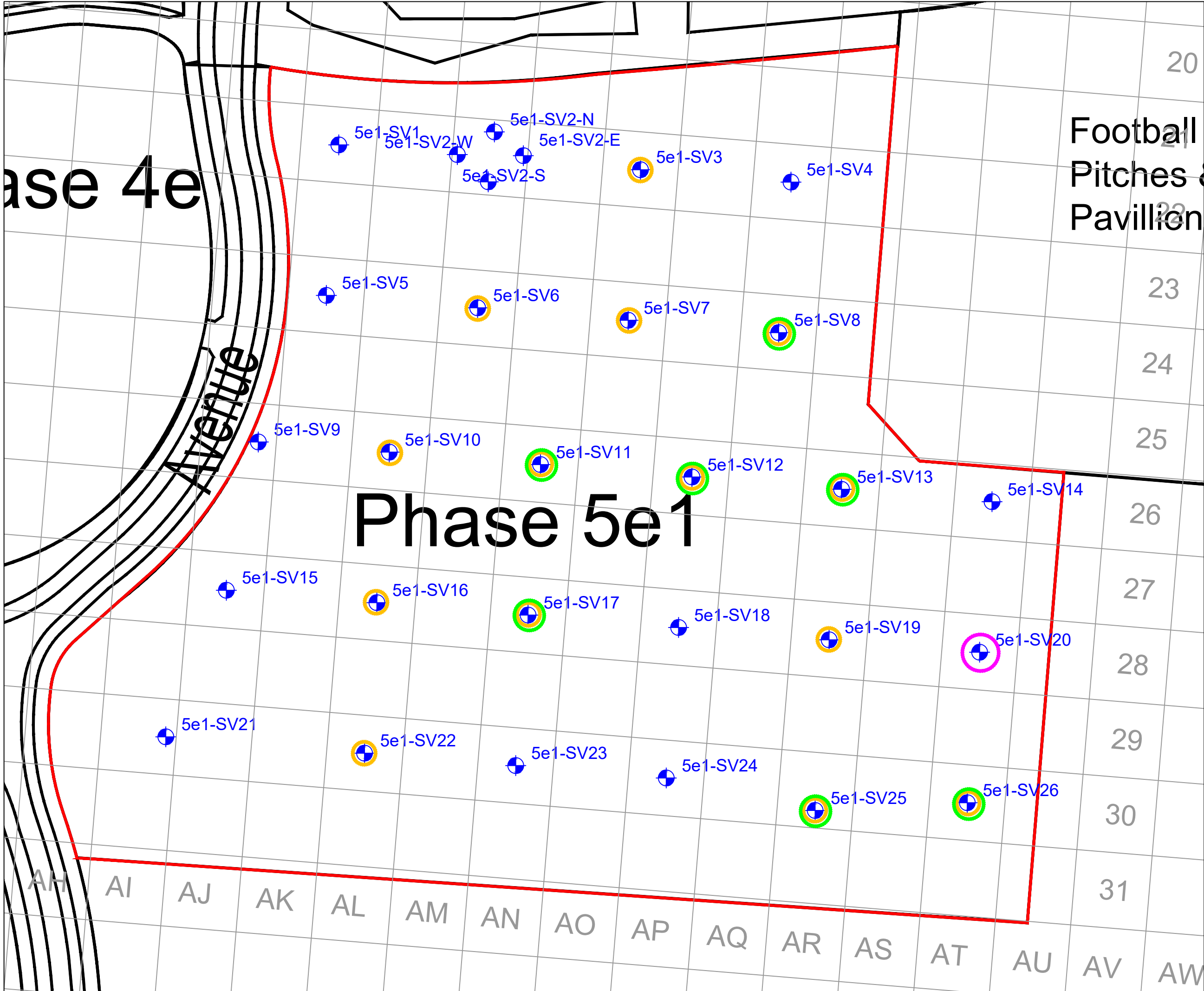
Client
St Modwen Developments

Project
P18-669 Llanwern Reclamation

Drawing Title
Phase 5E1
Chemical Validation Plan

INFORMATION

	Drawn	Checked	Date
NTS	CD	CW	06/09/22
Drawing No.	Rev.		
18669-RLL-22-XX-DR-O-0326	C		
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KEY:

- 5E1-SV SURFACE VALIDATION SAMPLE LOCATION
- BENZO[b]FLUORANTHENE EXCEEDANCE
- FLUORANTHENE EXCEEDANCE
- CYANIDE EXCEEDANCE

P01	14/06/2023	First Draft	ET	CW	
Rev	Date	Amendments	By	Chk	



Client
St Modwen Developments

Project
P18-669 Llanwern Reclamation
Phase 5E1

Drawing Title
Chemical Surface Validation
Exceedances

INFORMATION

	Drawn	Checked	Date
NTS	ET	CW	14/06/23
Drawing No.	Rev.		

18669-RLL-23-XX-DR-O-0422-P01

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- Key**
- Site boundary
 - Material suitable for residential
 - Material only failing metals
 - Material relocated to >30m from proposed watercourse
 - Reused stockpiles
 - Material from wider site
 - Material name and phase of origin
- W104 - 5e1



Client
St Modwen Developments

Project
Llanwern

Drawing Title
Phase 5e1 Material tracking

INFORMATION			
	Drawn	Checked	Date
NTS	ET	CW	15.06.23
Drawing No.			Rev.
18669-RLL-23-XX-DR-O-0443-P01			
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